Seawater Desalination with Solar Energy Technologies and Potential

REM Conference

Ravenna, March 1, 2012

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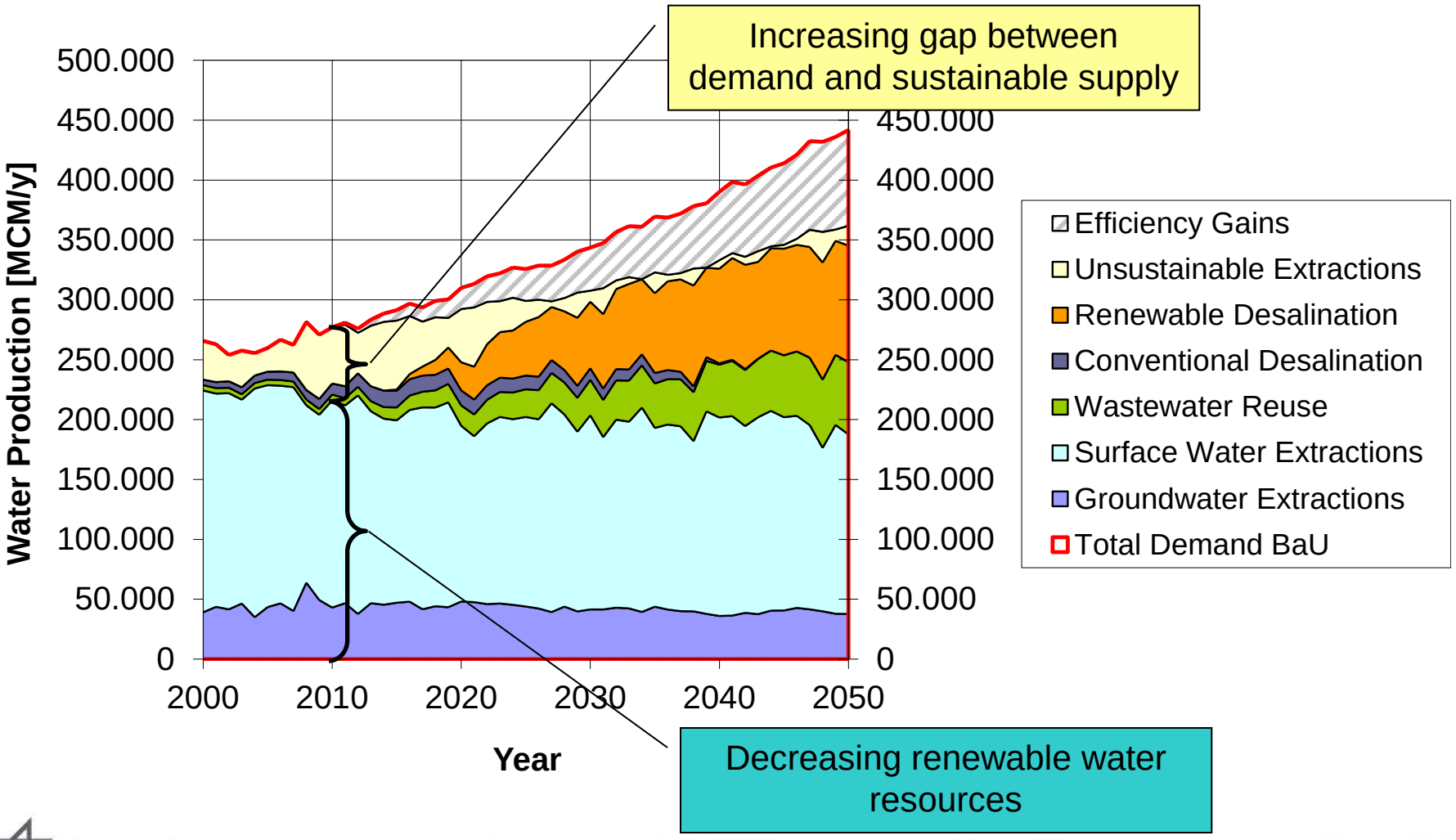
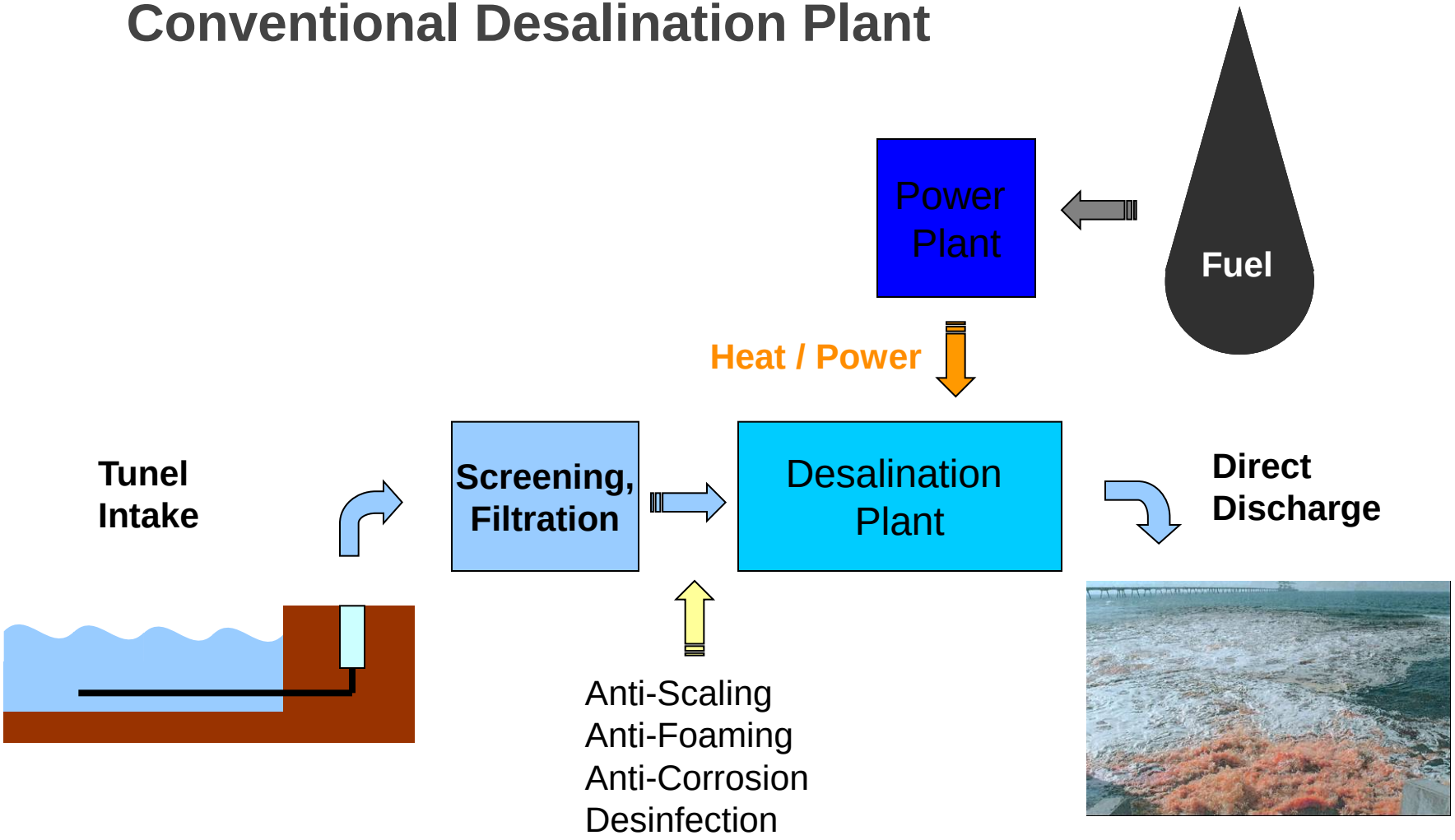
MENA Water Supply Scenario



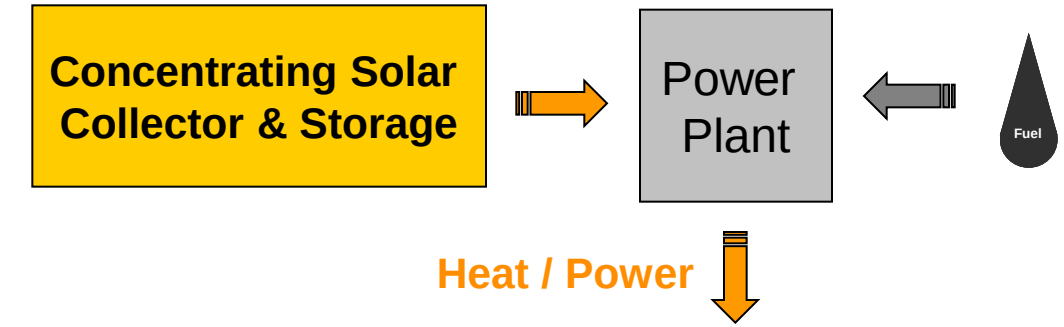
Conventional Desalination Plant



Impacts of Conventional Seawater Desalination

- Seawater intake for desalination and for the cooling system may cause impingement and entrainment of organisms
- Airborne emissions of pollutants and carbon dioxide are caused by the generation of electricity and heat required to power the desalination plants
- Chemical additives and biocides used to avoid fouling, foaming, corrosion and scaling of the desalination plants may finally appear in the brine
- Discharge of hot brine with high salt concentration to the sea may affect local species

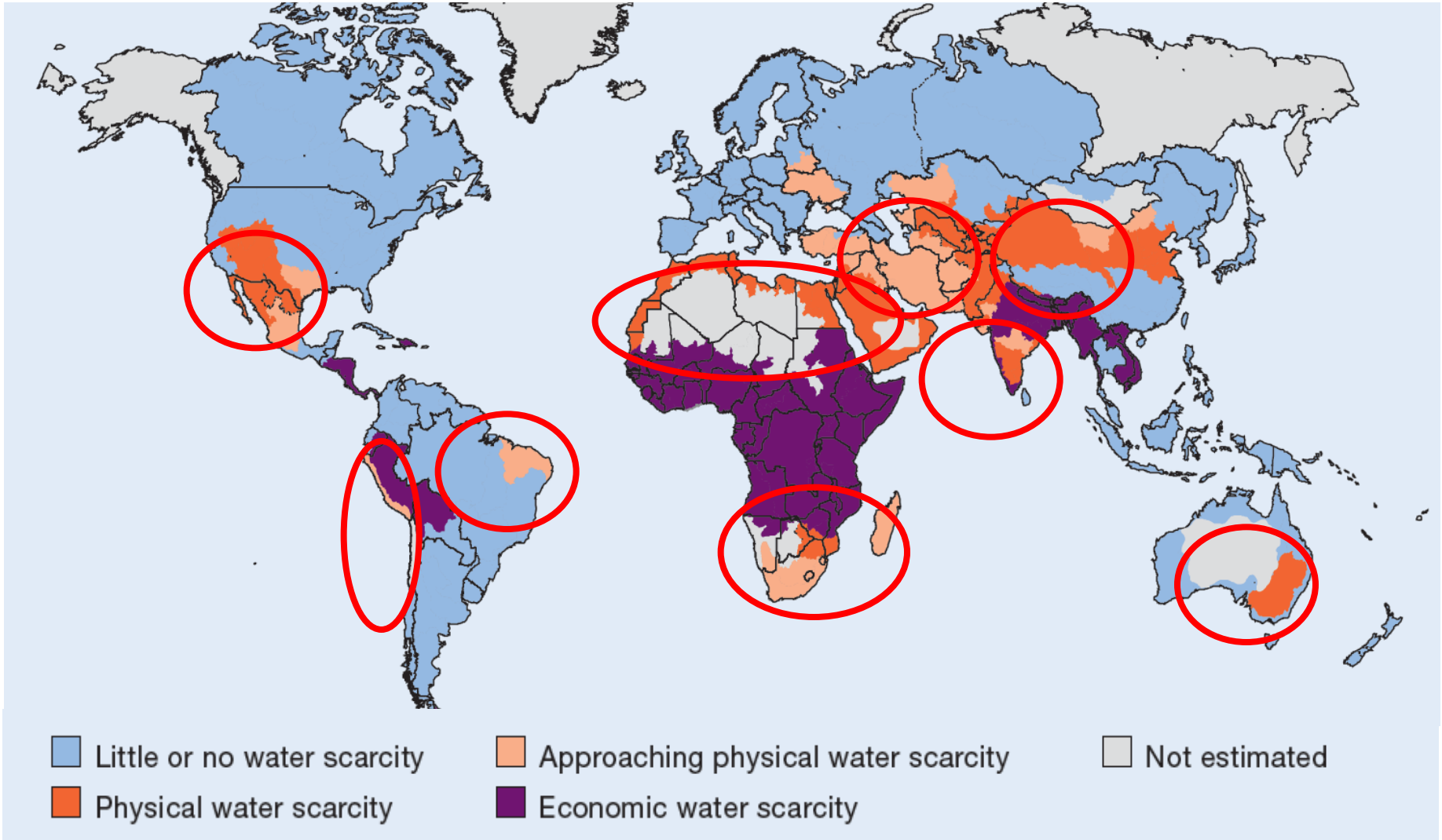
Advanced CSP-Desalination Plant



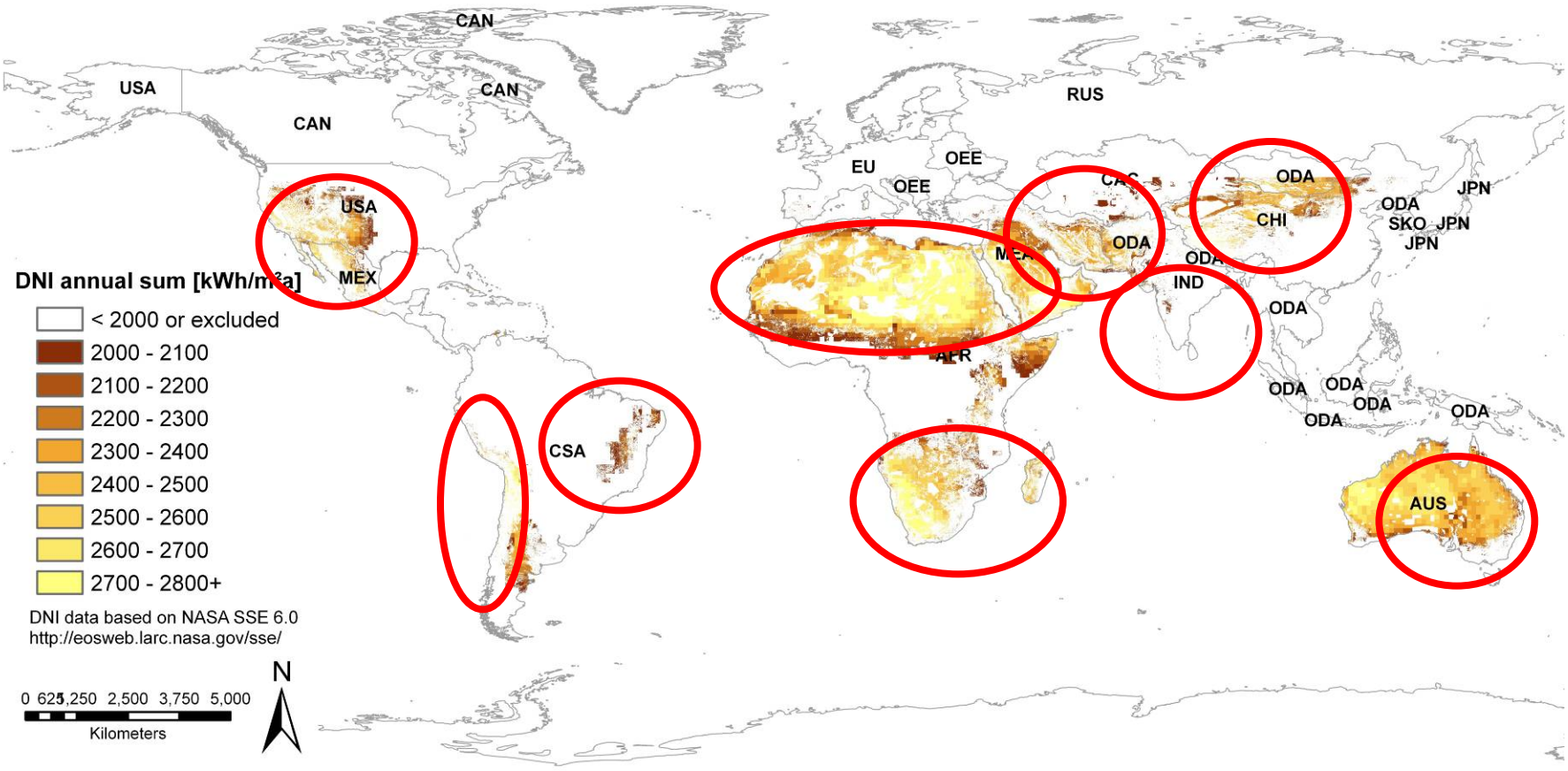
Horizontal Drain Intake or Micro- & Ultrafiltration

Multiport Diffuser Discharge

Global Water Scarcity



Global Potential for Concentrating Solar Power

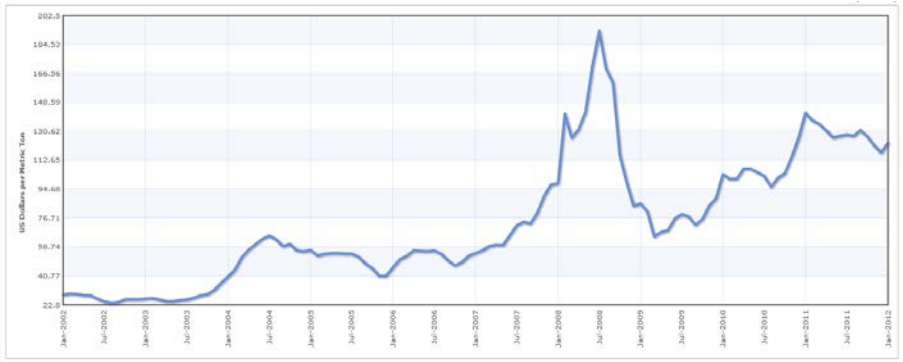


Data provided by DLR (2008) for EU-project REACCESS

Fossil fuels cost 2002 - 2012

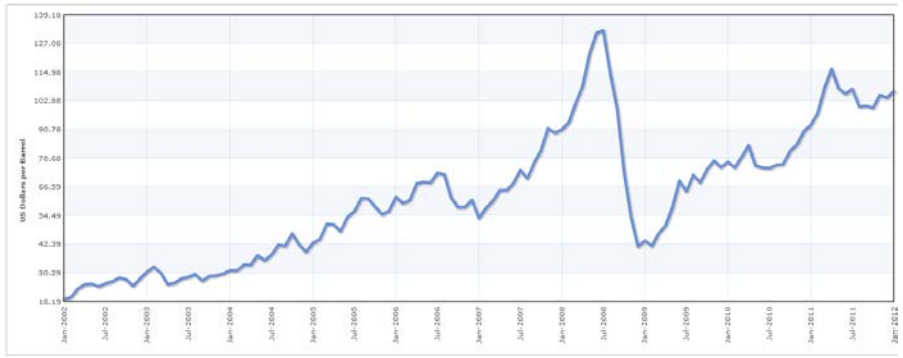
- Coal (Australia)

  x 4.2



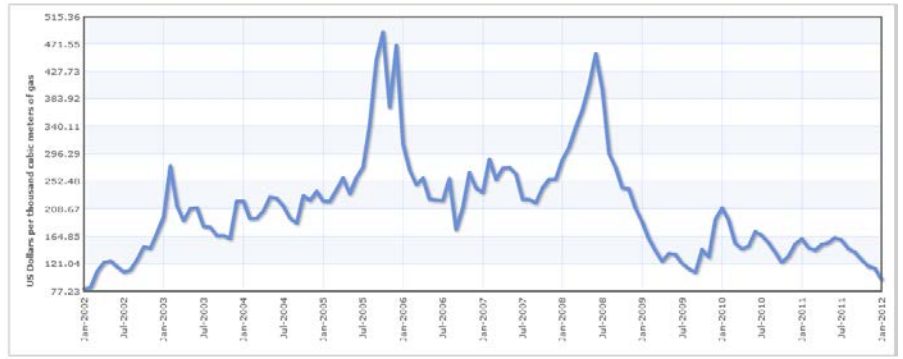
- Crude Oil

  x 5.6



- Natural Gas

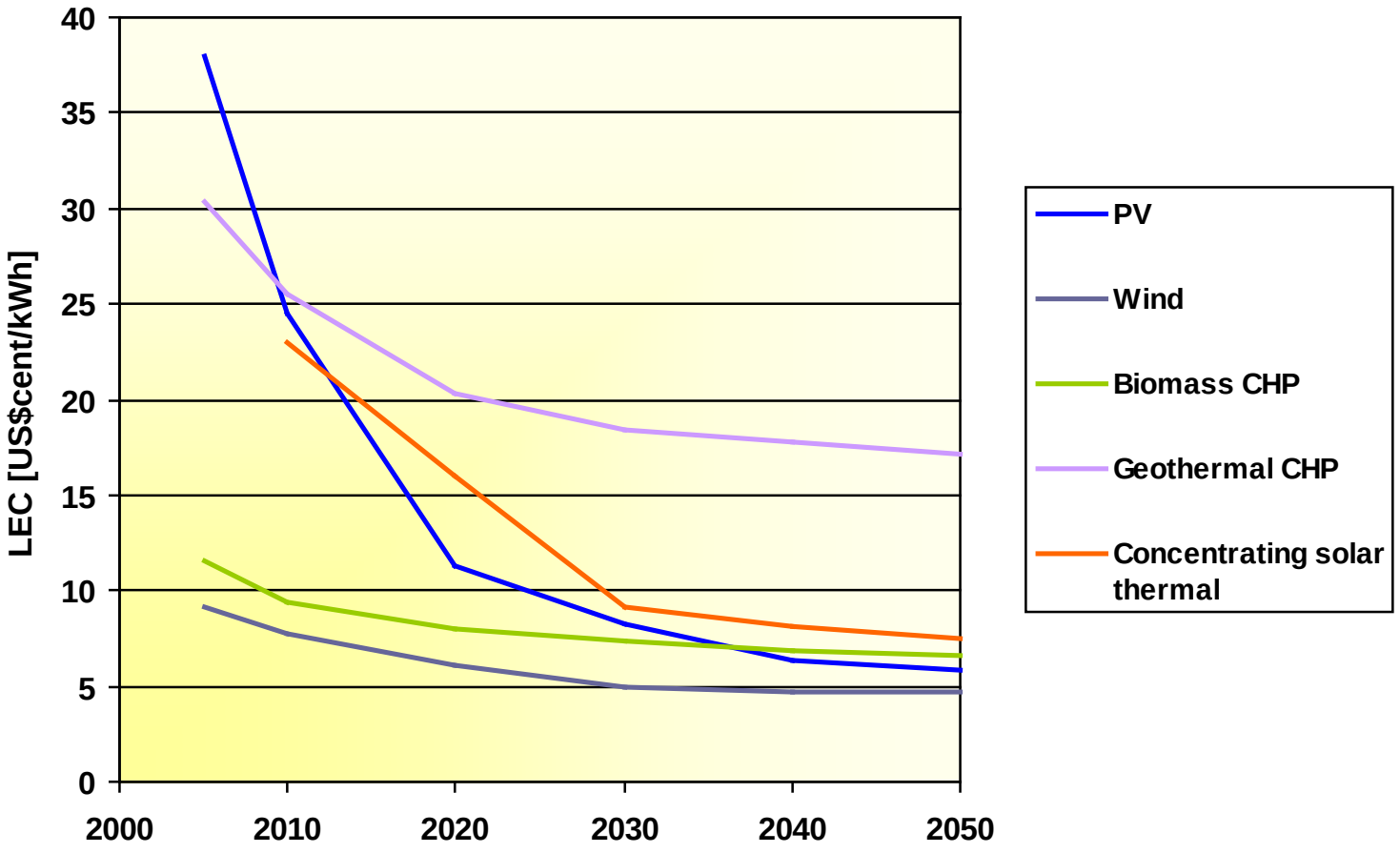
  x 1.2



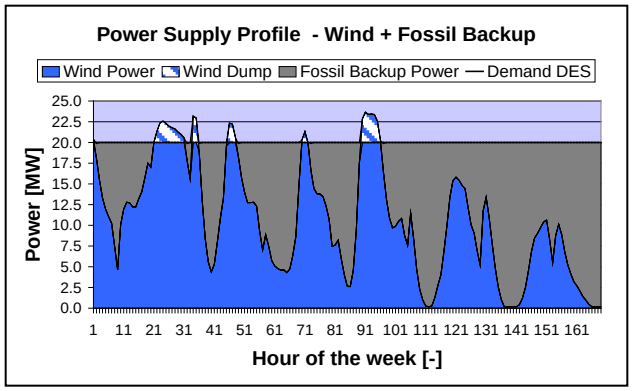
- Natural Gas (Russia)

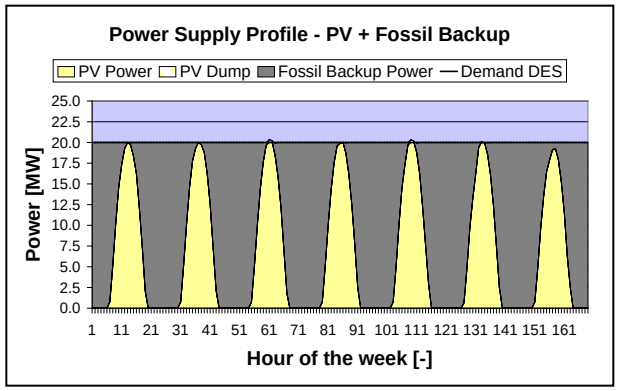
  x 4.4

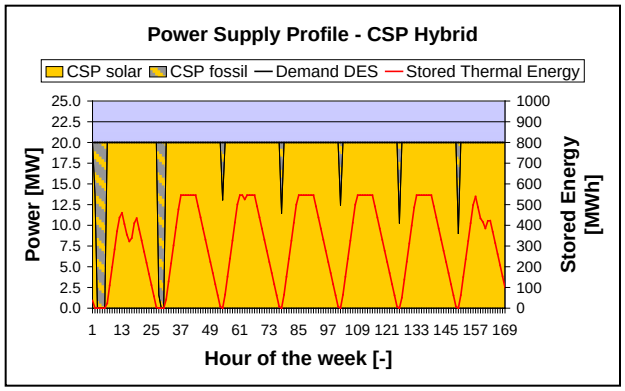
Learning Curves for Renewable Energies



Renewable Energies for Desalination: why CSP?







Wind PV CSP

Desalination plants require continuous operation

→ Conflict with the intermittent nature of renewable energies

→ CSP offers the option of thermal energy storage

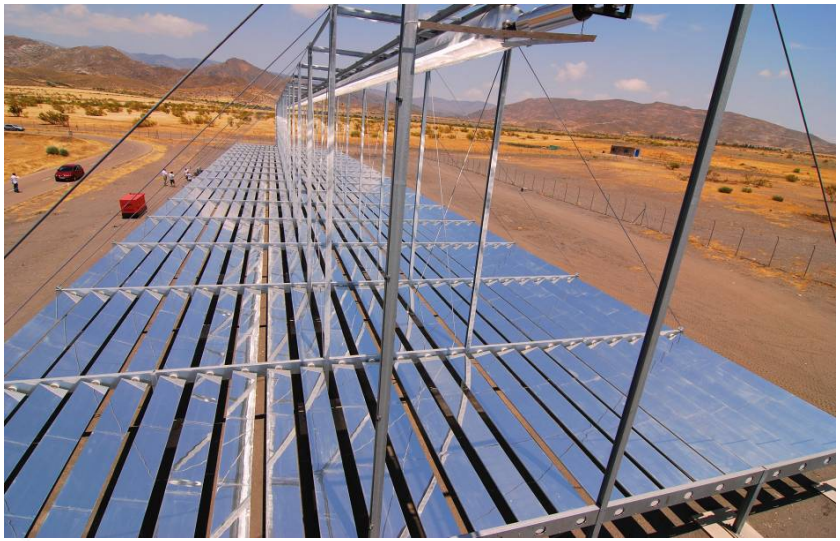
→ Hybrid operation is possible in the same power block (no “shadow power plant” required)

A fair technology comparison has to be carried out by definition of a load profile!

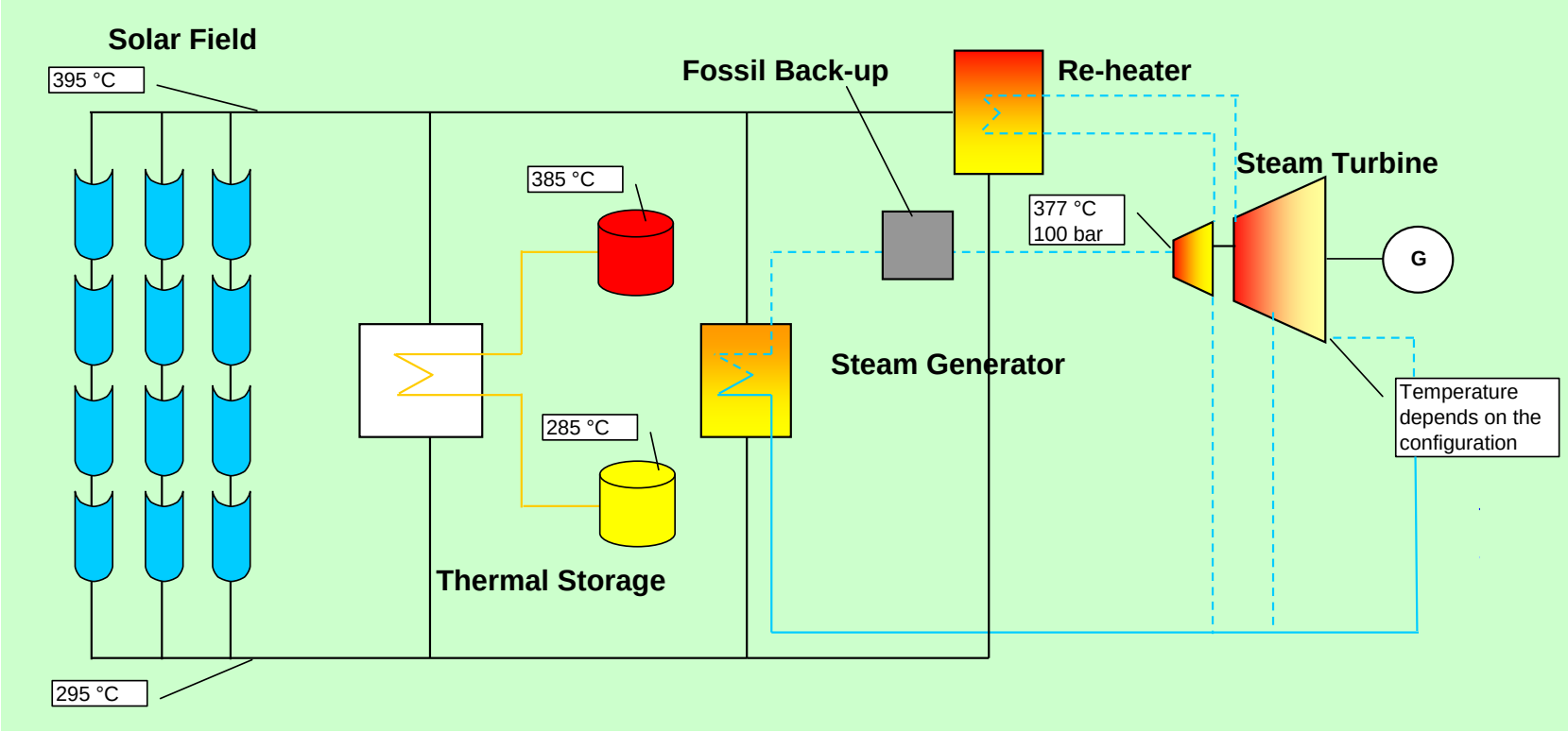
→ To Wind and PV cost, storage (if available) and back-up cost have to be considered

→ Grid import is not for free

CSP Technology Overview



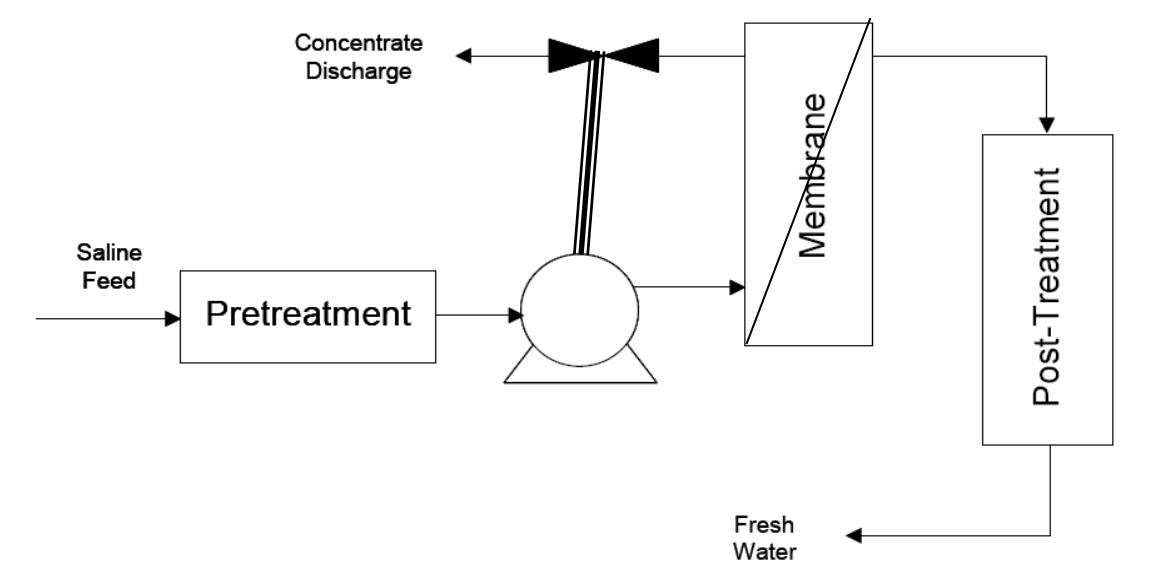
CSP Scheme


Solar Field
395 °C
Fossil Back-up
Re-heater
Steam Turbine
385 °C
377 °C
100 bar
G
Steam Generator
285 °C
Temperature depends on the configuration
Thermal Storage
295 °C

Reverse Osmosis (RO)

Membrane stacks and high pressure pumps

Heat	0	kWh_{th}/m^3
Power	3 - 6	kWh_{el}/m^3

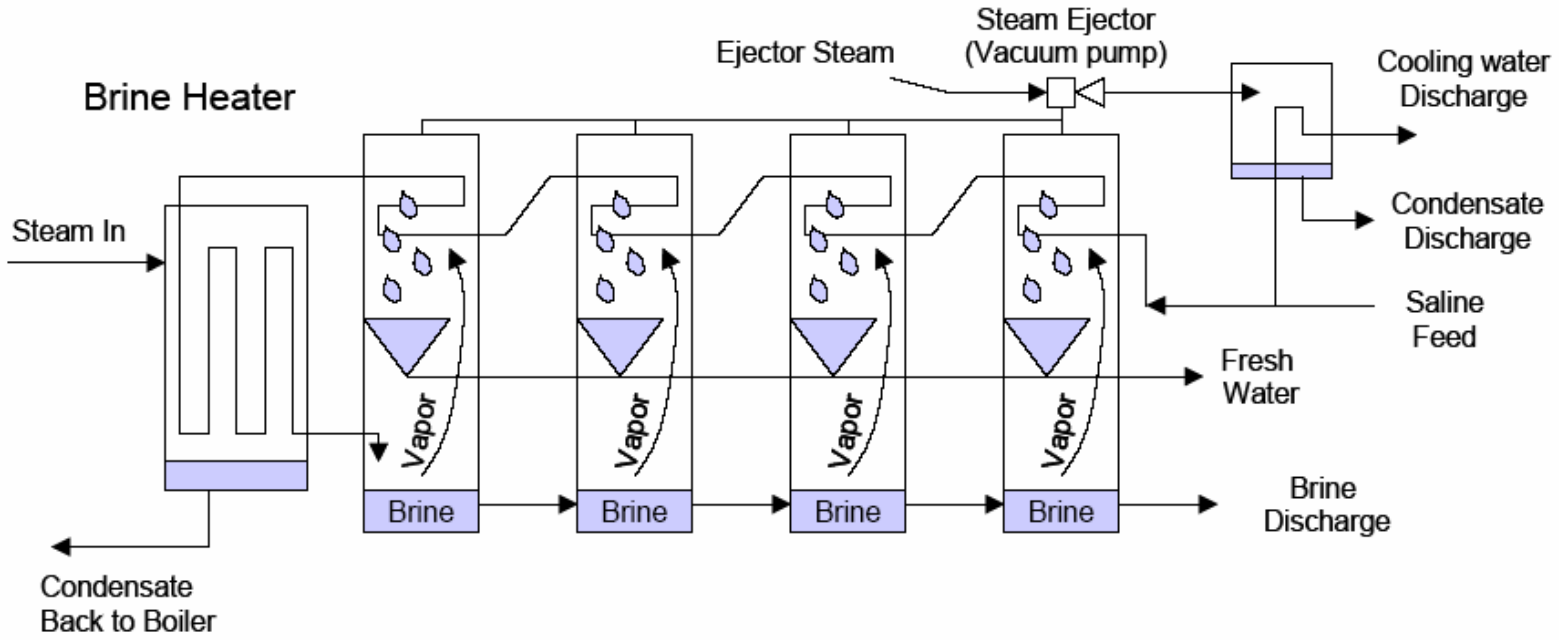


Source: DME

Multi Stage Flash (MSF)

Al Khobar, Saudi Arabia → 267,000 m³/day

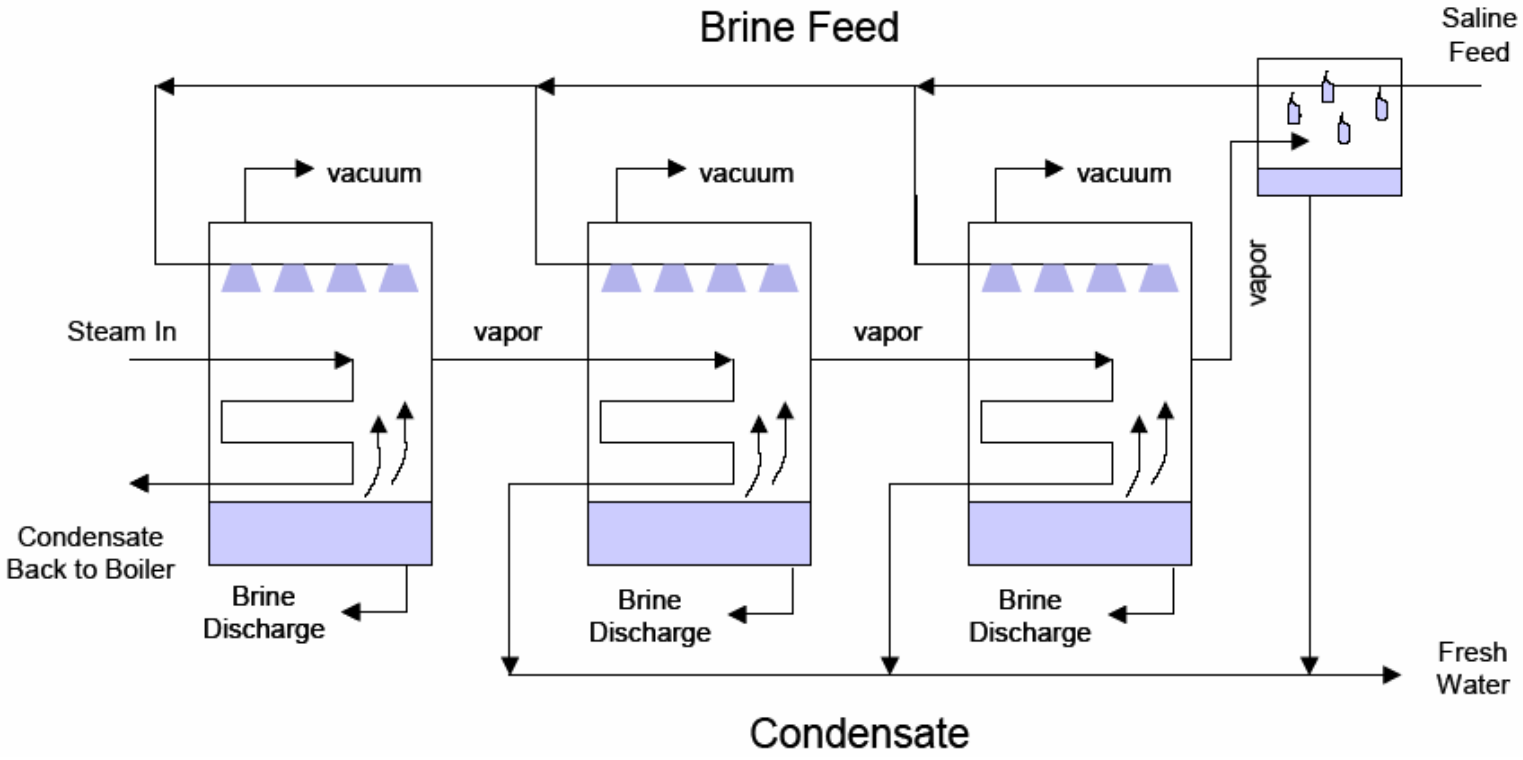
Stages	20 - 40	
Heat	70 - 125	kWh_{th}/m^3
Power	3 - 5	kWh_{el}/m^3



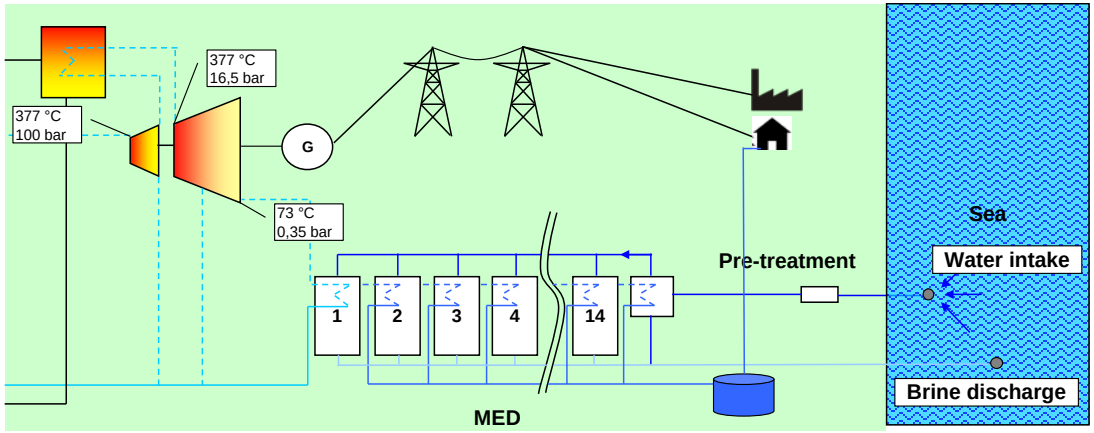
Multi Effect Distillation (MED)

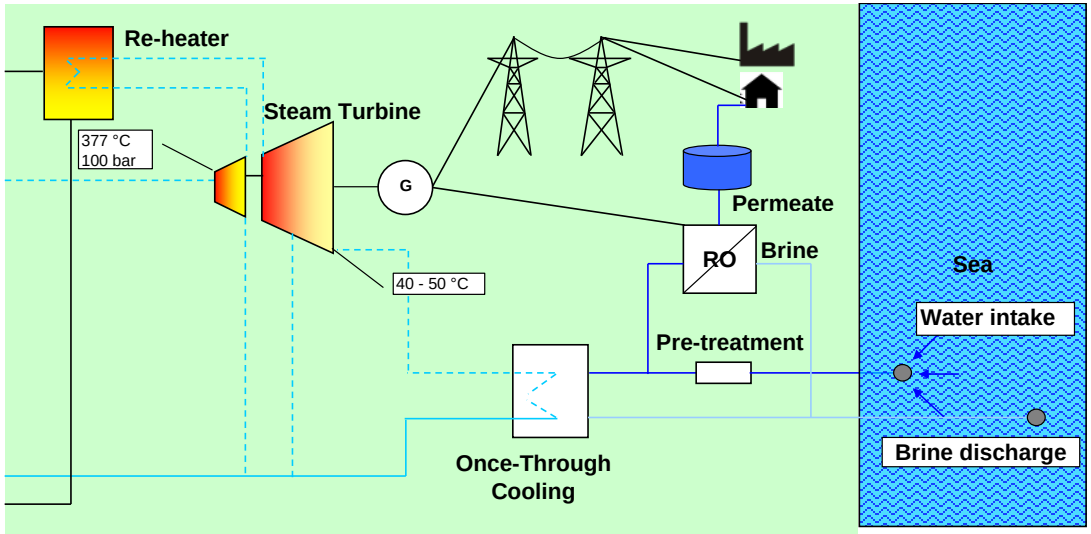
Abutaraba – Libya → 40,000 m³/day

Stages	8 - 12	
Heat	70 - 125	kWh_{th}/m^3
Power	1.5	kWh_{el}/m^3



Possible CSP-DES Configurations





- CSP: Parabolic Trough
- 2 desalination technologies:
  MED: Multiple-Effect-Distillation
  RO: Reverse Osmosis
- Desalination: 100,000 m^3/d
- Power: ca. 100 MW_{el}
- Storage: 7.5 h (design)
- Plant operation: 8,000 h/y
  including fossil fuel back-up
- Levelized cost of electricity:
  20 – 24 US$cent/kWh
- Levelized water cost:
  1.5 – 1.9 US$/$m^3$

Conclusions

- High uncertainty on future water availability! Unmet water demand of MENA in 2050 between 85 km^3 and 283 km^3 (average scenario 199 km^3)
- A set of countermeasures is urgently required: increased efficiency of water production, distribution, end-use and management, re-use of waste water, sustainable desalination
- Yearly adaptation cost US$ 103 Billion $€_{2010}$.

  Yemen (11.8%), Iraq (7.5%), Morocco (4.7%), Jordan (4.0%) and Egypt (2.4%) will face the highest cost in relation to the GDP
- Almost all countries have enough potential to develop CSP also on coastal areas
- Start to act now in order to build-up the required industrial capacities. Political support is required!

Thank you for your attention!

For more Info:

www.dlr.de/tt/menawater

www.med-csd-ec.eu

www.dlr.de/tt/aqua-csp

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